

In the first two of the four VGS systems as now proposed, the tracked vehicle would include active targets that would light up on command from the tracking vehicle, and a video camera on the tracking vehicle would be synchronized with, and would acquire images of, the active targets. The video camera would also acquire background images during the periods between target illuminations. The images would be digitized and the background images would be subtracted from the illuminated-target images. Then the position and orientation of the tracked vehicle relative to the tracking vehicle would be computed from the known geometric relationships among the positions of the targets in the image, the positions of the targets relative to each other and to the rest of the tracked vehicle, and the position and orientation of the video camera relative to the rest of the tracking vehicle.

The major difference between the first two proposed systems and prior active-target VGS systems lies in the techniques for synchronizing the flashing of the active targets with the digitization and processing of image data. In the prior active-target VGS systems, synchronization was effected, variously, by use of either a wire connection or the Global Positioning System (GPS). In three of the proposed VGS systems, the synchronizing signal would be generated on, and transmitted from, the tracking vehicle.

In the first proposed VGS system, the tracking vehicle would transmit a pulse of light. Upon reception of the pulse, circuitry on the tracked vehicle would activate the target lights. During the pulse, the target image acquired by the

camera would be digitized. When the pulse was turned off, the target lights would be turned off and the background video image would be digitized.

The second proposed system would function similarly to the first proposed system, except that the transmitted synchronizing signal would be a radio pulse instead of a light pulse. In this system, the signal receptor would be a rectifying antenna. If the signal contained sufficient power, the output of the rectifying antenna could be used to activate the target lights, making it unnecessary to include a battery or other power supply for the targets on the tracked vehicle.

The third proposed VGS system could include either passive or active targets. This system would include two or more video cameras and associated digitizing and digital image-processing circuitry on the tracking vehicle for acquiring stereoscopic pairs of images of the targets on the tracked vehicle. At distances beyond the normal VGS operating range (that is, at distances so great that the target images would merge into a single spot of light on each camera focal plane), a VGS system operating in its normal short-range mode could determine the direction to the tracked vehicle but could not determine the distance to, or the orientation of, the tracked vehicle. However, in such a situation, this proposed system would determine the distance to the tracked vehicle by use of the known geometric relationships of stereoscopy — provided, of course, that the distance were not so great as to bring the stereoscopic disparity below the minimum useful level.

The fourth proposed system would be an active-target VGS system in which synchronization would not involve the transmission of pulses from the tracking vehicle. Instead, the target lights would be flashed at a repetition rate of 5 Hz governed by a free-running oscillator on the tracked vehicle. Each flash period would include a lights-on interval of 3/60 of a second (corresponding to three video fields at standard video frame rate of 30 Hz at two fields per frame) and a lights-off interval of 9/60 of second. The system would digitize two pictures in a row, subtract them, and look for the expected target pattern in each synthetic image generated by the subtraction. If the target pattern were thus found, then the flash timing would be known to within one field. If the target pattern were not found, then the time of each picture would be advanced one frame (two fields — 1/30 of a second) relative to the beginning of a 5-Hz processing cycle and the aforementioned actions repeated. This process would quickly bring the digitizing and data-processing circuitry into synchronism with the flashing of the targets.

This work was done by Thomas C. Bryan, Richard T. Howard, and Michael L. Book of Marshall Space Flight Center. Further information is contained in a TSP (see page 1).

This invention has been patented by NASA (U.S. Patent No. 6,254,035). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to Sammy Nabors, MSFC Commercialization Assistance Lead, at (256) 544-5226 or sammy.nabors@msfc.nasa.gov. Refer to MFS-31278/79/80/81.

Simulating Remote Sensing Systems

Stennis Space Center, Mississippi

The Application Research Toolbox (ART) is a collection of computer programs that implement algorithms and mathematical models for simulating remote sensing systems. The ART is intended to be especially useful for performing design-tradeoff studies and statistical analyses to support the rational development of design requirements for multispectral imaging systems. Among other things, the ART affords a capability to synthesize coarser-spatial-resolution image-data products. The ART also provides for simulations of

image-degradation effects, including point-spread functions, misregistration of spectral images, and noise. The ART can utilize real or synthetic data sets, along with sensor specifications, to create simulated data sets. In one example of a particular application, simulated imagery of a coarse resolution system was created using high-resolution imagery from another system in order to perform a radiometric cross-comparison. In the case of a proposed sensor system, the simulated data can be used to conduct trade studies and statistical analyses

to ensure that the sensor system will satisfy the requirements of potential scientific, academic, and commercial user communities.

This collection of programs was written by Vicki Zanoni of Stennis Space Center and Robert Ryan, Slawomir Blonski, Jeffrey Russell, Gerald Gasser, and Randall Greer of Lockheed Martin Corp.

Inquiries concerning rights for the commercial use of this invention should be addressed to the Intellectual Property Manager, Stennis Space Center, (228) 688-1929. Refer to SSC-00181.